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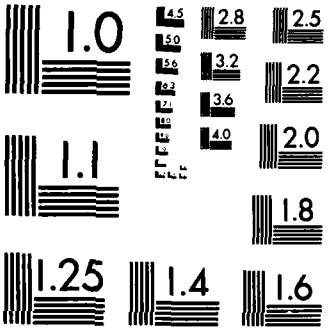

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G PROTECTION BY AN EXTREME CROUCH POSITION

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In World War II the pilots of diving bombers tolerated high G loads by assuming a crouch position. The Dynamic Flight Simulator (Human Centrifuge) was used to prove the advantages of the crouch position. Two subjects were located in an extreme crouch position, the upper spine being at an angle of 80 to 90 degrees from the vertical. They tolerated 6.5 and 7.5 G respectively. Both subjects have tolerated only 3.5 G in former experiments when seated upright. The use of an Anti-G suit did not improve further the G tolerance. Both subjects abandoned the experiment not because of the Loss of Vision, but because of the discomfort of overfilling of the facial area with blood. It is planned to find a crouch position where the vision is still maintained and the blood filling of the facial area is mitigated. This would probably be a crouch position of 45 to 60 degrees from the vertical.

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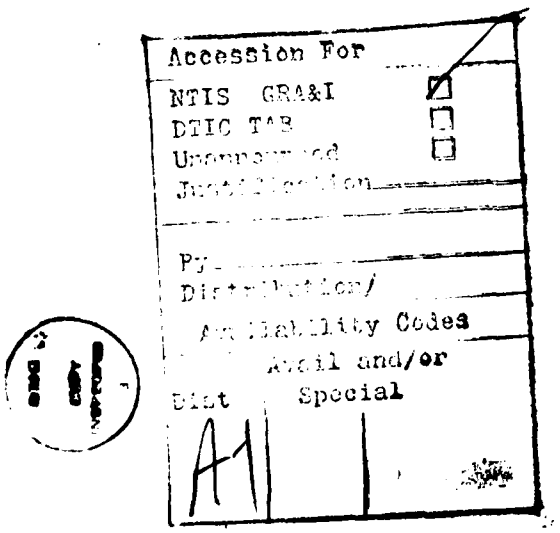

HISTORICAL BACKGROUND

During World War II the aircraft which generated the highest accelerations were the German dive bombers, Junkers Ju 87 and Ju 88, and the fighter aircraft, Messerschmitt Me 109 and Focke-Wulf Fw 190. The pilots were indoctrinated to fight high "G" forces by flying in the crouch position and by increasing the abdominal pressure by shouting high pitched sounds like "e-e-e-e-e-e". Although this proved very effective in increasing "G" tolerance, the pilots in the crouch position lost their out-of-the-windshield vision (reference (1)), shown in figure 1.

The Ju 88 had an automatic recovery mechanism. Before he dove, the pilot dialed in the altitude at which he wanted to recover. After the di , the aircraft recovered at the desired altitude even when the pilot had lost consciousness.

Today with the progress in optical devices, it would not be difficult to provide a TV screen and some of the essential instruments on the cabin floor, easily read by a pilot in the crouch position.

METHODS

The NAVAIRDEVCEN Dynamic Flight Simulator (Human Centrifuge) was used for these experiments. The Acceleration Profile was an onset and offset drive of 8 seconds. The G plateaus had a duration of 15 seconds and began with 3.5 G until 7.5 G with an increase of 1 G per run. The subjects were restrained by a tight abdominal belt. The shoulder straps of the torso harness were loose enough to allow an extreme crouch position: The lower spine was at an angle of 40 degrees and the upper spine at an angle of 80 to 90 degrees (both measured from the vertical). Excessive forward neck flexion was limited by a padded strap (figure 2) which supported the subject's head and was mounted on two rails, which were located on either side of the subject.

INSTRUMENTATION

The instrumentation consisted of two ECG channels, heart rate, G-profile, a low-light level TV camera (figure 3), directed towards the subject's face, with displays on the TV screens of the Flight Director, the Medical Officer and the Project Officer, and in addition, on a Video Cassette Recorder during the run, a light box (figure 3), with two incandescent red light bulbs for illumination of the subject's face, stop-the-run buttons for the subject, the Medical Officer, the Flight Director, a Doppler Flow Velocity Transceiver over the subject's right temporal artery (figure 4) and a light bar (figure 3), which carries a green light bulb in the center and at 15 inches distance two red light bulbs. The subjective dimming of these lights indicate the subject's beginning grey-out and black-out repectively. In our experiments grey-out and black-out did not occur.

RESULTS

Subject 1: Male, 28 years old, very experienced in centrifuge acceleration experiments.

Subject 2: Female, 22 years old, experienced in centrifuge acceleration experiments.

On the first day of experimentation (22 August 1984) both subjects were exposed to accelerations, with the Anti-G suit not inflated. Subject 1 was exposed to a plateau of 2.5, 3.0, 4.0, 4.5, 5.5 and 6.5 G. The run of 6.5 G was stopped by the subject after 22 seconds.

In former experiments he tolerated only 3.5 G sitting upright, without the protection of Anti-G suit. Subject 2 was exposed to 2.5, 3.5, 4.5, 5.5, 6.5 and 7.5 G. She finished the 7.5 G run, but did not want to continue. In former experiments the subject tolerated sitting upright also only 3.5 G.

On the second day of experimentation (23 August 1984) the inflated Anti-G suit was used by both subjects. The G suit was modified by the removal of the abdominal bladder which would not have allowed the extreme crouch position. Only the bladders of the thighs and of the calfs were inflated. Subject 1 was exposed to 3.5, 4.5, 5.5, 6.5 and 7.0 G. The 7 G run was stopped by the subject after 24 seconds. It was the wish of the subject to repeat the 7 G run without the inflated Anti-G suit. He stopped the run after 26 seconds, but it was his opinion that without the Anti-G suit the run is more comfortable. Subject 2 was exposed to 3.5, 4.5, 5.5 and 6.5G and refused to make more runs.

DISCUSSION

a. The G tolerance is doubtlessly increased by the extreme crouch position: 6.5 G (Subject 1) and respectively 7.5 G (Subject 2) versus 3.5 G (both subjects) in upright seated position.

b. The Anti-G suit causes no further improvement of the G tolerance.

c. Both subjects could at all times observe the green and red lights of the light bar and suffered no grey-out or black-out.

The discomfort caused by the engorgement of the face with blood, however was remarkable and caused in all cases the abandon of the experiments. This is easily explained when we observe figure 5: The retinal-aortic line is forward bent with respect to the anatomical z axis by 15 degrees. At a 45-degree crouch position the angle between the retinal-aortic line and the vertical is no longer 45 degrees but now 60 degrees from the vertical. When the trunk is bent forward to a nearly horizontal position as in our experiments, the retinal aortic line is 10 to 15 degrees below the horizontal, which explains the blood filling of the eyeball and the face. It is understood that the subjects did not suffer grey-out and black-out and could at all times see the red and green lights of the light bar (figure 3). However, they suffered petechiae on upper and lower eye lid, and on the dorsum of the hand, facial pain and fatigue; these signs were the reason for terminating the experiments. The petechiae resolved after a few days.

An interesting physiological response was noted in these experiments. A very significant bradycardia was noted in both subjects during the G plateau: Forty heart beats per minute from a base line of seventy beats per minute. This is presumably a vagal reflex to the increased pressure in the carotid sinus in this configuration.

FUTURE EXPERIMENTS

It will be the subject of our future experimentation to find a crouch position where the vision is maintained and the blood filling of the face is mitigated. That would be at my opinion a crouch position of 45 to 60 degrees, as shown in figure 6.

Mr. D. Lorch, from our organization, is developing a restraint system that would support the subject in the desired crouch position of 45 to 60 degrees by means of a cable fixed on the hind part of the helmet and a special torso harness, shown in figure 7.

The Stanley Corporation developed a similar harness although for another purpose (Reference (2)): In ejection seats, it pressed the torso before the ejection, against the seat back to avoid spinal injuries.

It is hoped to find an optimal crouch position which avoids black-out and does not cause the described inconveniences of overfilling of the facial area.

REFERENCES

(1) von Diringshofen, H.: "Medizinischer Leitfaden fuer Fliegende Besatzungen". (Medical Manual for Flying Personal), Page 134, Published T. Steinkopf, Germany, 1939.

(2) Stanley Corporation, Denver, CO: Torso-Head Restraint System, Summary Contract Report, Bureau of Aeronautics NO-ES 57-7-737-C, 30 Sep 1952.

(3) von Beckh, H. J.: "Fisiologia del Vuelo" (Physiology of Flight) page 78, Publisher Alfa, Buenos Aires, 1955.

(4) von Beckh, H. J.: The Development and Airborne Testing of the PALE Seat. Report No. NADC-81200-60, 20 Jun 1981.

(5) von Beckh, H. J.: The Beginnings of Aeromedical Acceleration Research. Report No. NADC-81281-60, 30 Sep 1981.

Figure 1. The Crouch Position (In German: "Zusammengekauerte Sitzhaltung") as described by H. von Diringshofen. From: H. von Diringshofen: "Medizinischer Leitfaden fuer Fliegende Besatzungen" (In English: Medical Manual for Flying Personnel"), page 134, Publisher T. Steinkopf, Germany, 1939.

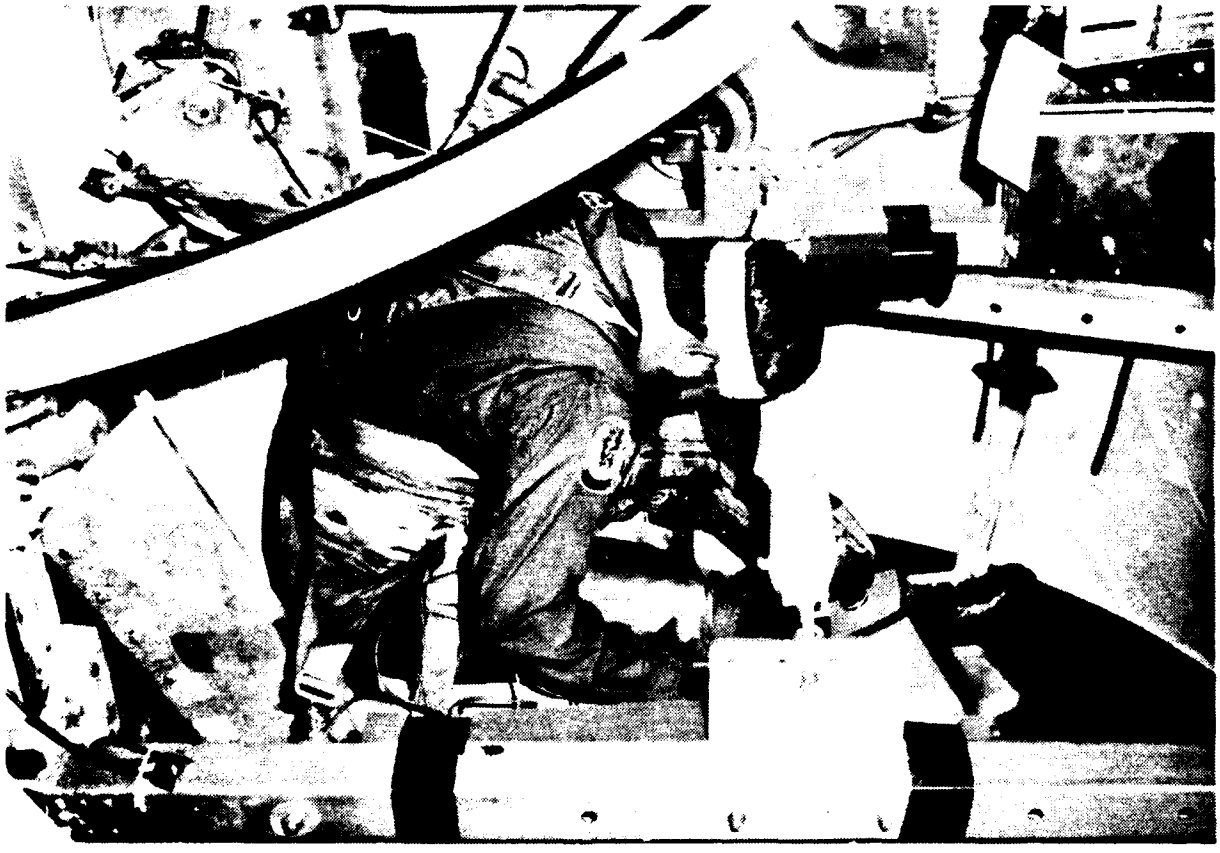

Figure 2. Subject #1 in the gondola in extreme crouch position. His forhead rests on a padded strap. A TV camera is mounted between his boots and is directed towards his face.

Figure 3. The empty seat. It shows the low light level TV camera (General Electric Model 4 TE 50 PIFAT 520). The picture was displayed on the TV screens of the Flight Director, of the Medical Officer, and the Project Officer. In addition it was recorded on a Video Cassette Recorder.

Left of the camera is a light box with two red incandescent Light Bulbs for illumination of the subject's face.

On the far right is to be seen the "Light Bar" which carries in the center a green light bulb and at 15 in. distance two red light bulbs. The subjective dimming of these lights indicate the Subject's beginning grey-out and black-out respectively. In our experiments, however, grey-out and black-out did not occur.

Figure 4. The sensor of the Doppler Flow Meter is fixed over the right temporal artery of Subject #2. In our experiments the Doppler Flow Meter was of limited use because blood flow to the head was never interrupted.

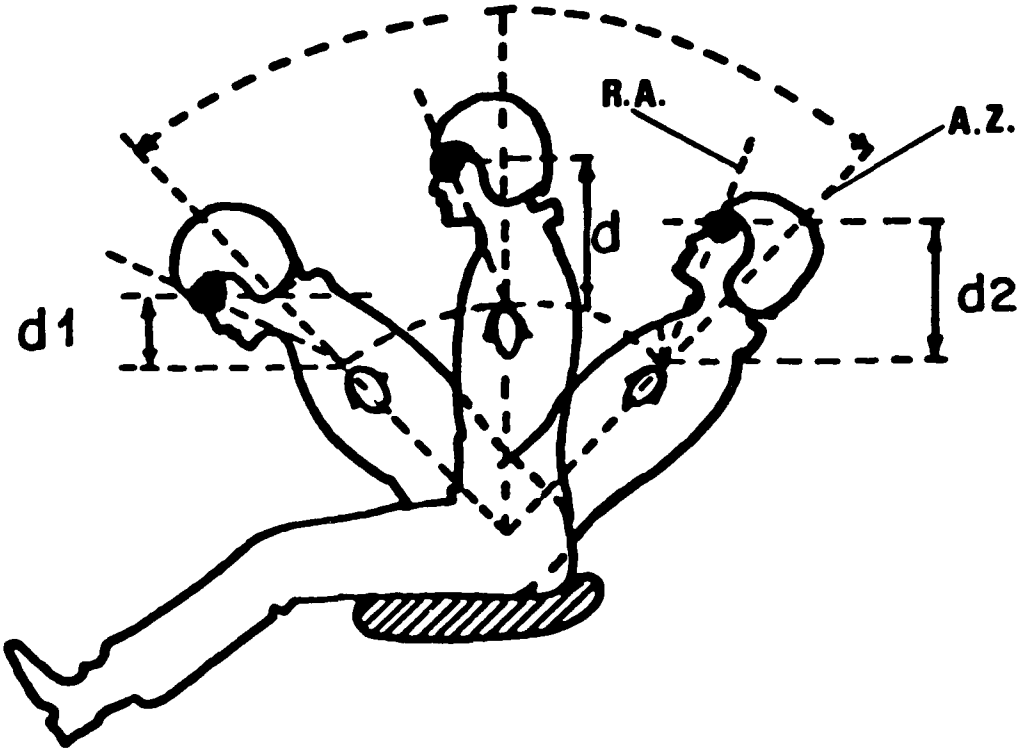

Figure 5. A simplified representation of the increase and decrease of the vertical distance between heart and eyeball in different body positions. Key: d = vertical distance between heart and eyeball in upright seated position; d_1 = idem, when titled 45 degrees forwards ("Crouch position"); d_2 = idem, when titled 45 degrees backwards ("Semi-supine position"); R.A. = Retinal-aortic line; A.Z. = Anatomical Z axis. From: H. J. von Beckh: "Fisiologia del Vuelo", page 78, Publisher ALFA, Buenos Aires, 1955.

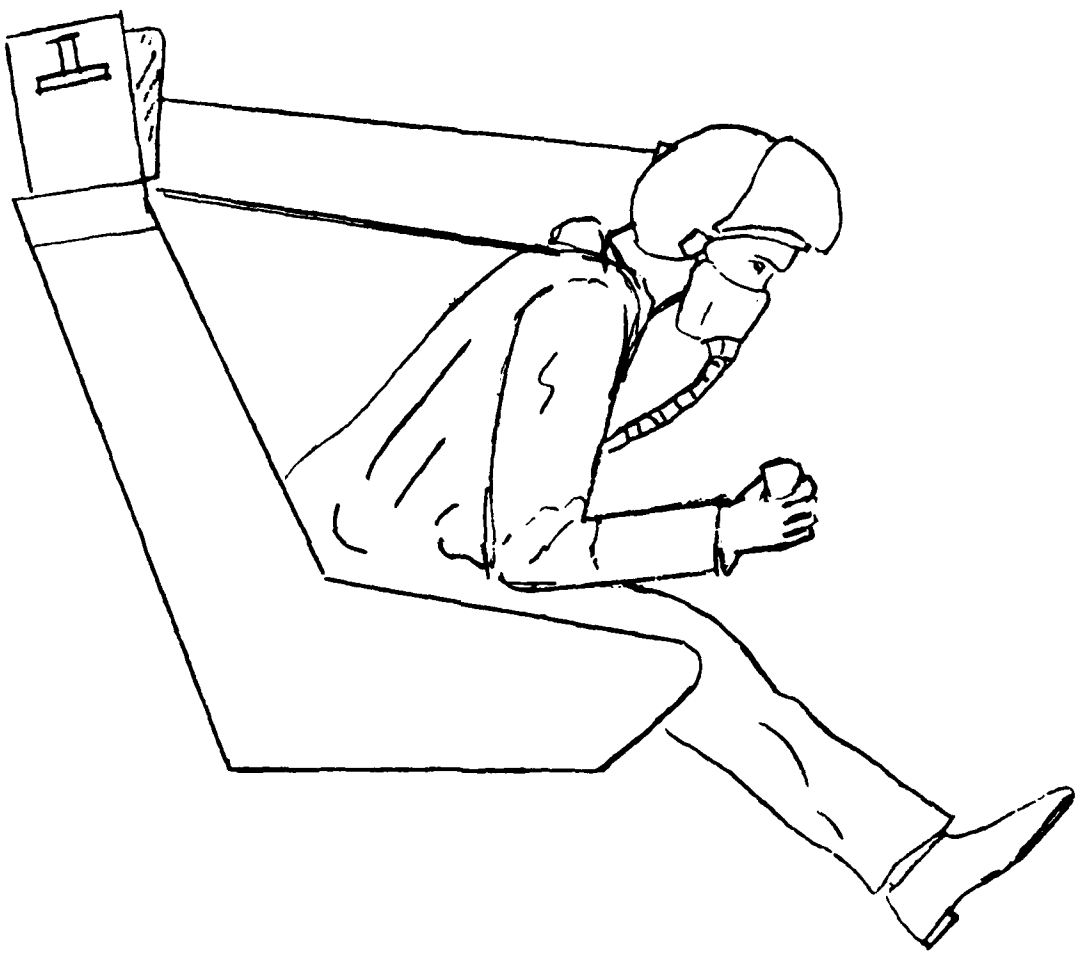

Figure 6. Artist conception of our future Crouch Position Experiments. It is foreseen to study above all Crouch Positions of 45 to 60 degrees. The subject's head is maintained in the desired position by a cable fixed on the seat back and the back part of his helmet. The trunk will be maintained by a special harness.

Figure 7. The modified Anti-G suit used in the second series of G-exposures. The abdominal bladder is removed because it would not have allowed the extreme Crouch Position. Only the two calf and leg bladders were inflated.

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